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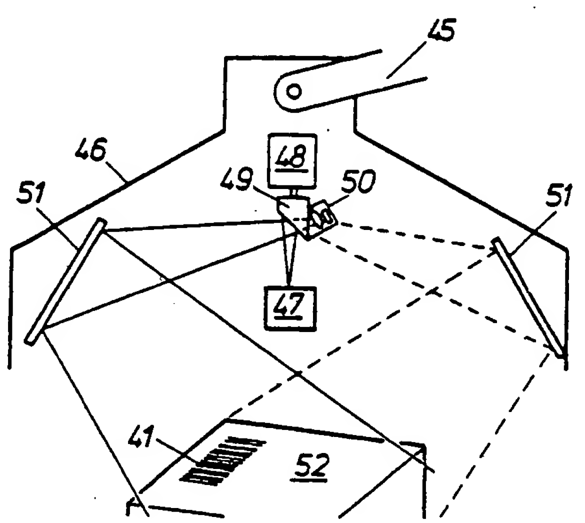

(57) Abstract

A line-code reader comprises a deflection instrument with a laser (47), from which light in a laser-sweep pattern from an electrically controllable reflecting device is transmitted towards a rotating mirror (49), and via additional stationary mirror (51) the light is thrown down towards a product (52) with a line-code label (41) which is to be read. The light reflected from the line-code label is scanned by means of a photocell (50). The controllable reflecting device in the deflection instrument (47) is supplied with electrical signals or voltages of a frequency or modulated with a frequency of or in the vicinity of the resonant frequency or harmonics hereof for the mechanical oscillation system of which the mirror forms a part.

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DEFLECTION INSTRUMENT, CONTROLLABLE REFLECTING DEVICE HEREFOR AND USE HEREOF.

The invention relates to a light deflection instrument of the kind disclosed in claim 1.

Electrically-controllable reflecting devices of the kind disclosed in the preamble to claim 1 are known, for example from Japanese patent publication no. 52-40215, wherein the reflecting device comprises a mirror mounted on two or more arms of piezoelectric material, possibly flexible piezoelectric material, which upon application of an electrical voltage between the upper side and the lower side of the crystal material causes the arms to bend slightly. If the crystal materials are connected in pairs to the applied voltage in counter-phase, the mirror will tilt, and thus it is possible to electrically control the tilting of the mirror both with regard to the extent of the tilt and its direction. If four crystals in cruciform configuration are used, the mirror can be controlled so that an incident beam of light can be reflected as desired. The deflection of the mirror is, however, quite small, in that the maximum deflection of the crystal is in the order of 0.05 mm to each side, and the practical use of such devices is therefore strongly limited. In order to increase the deflection of the mirror, and to make it possible to use a thicker and herewith a more solid but also heavier mirror, a number of crystal elements can be mechanically coupled in series, which is known for example from USA patent publication no. 4,660,941. However, this results in a mechanically complicated construction,

and while the possibility is no doubt provided of greater mirror deflection, the deflection on the other hand is considerably slower, which for some applications is totally unacceptable.

From USA patent publication no. 3,981,566, a deflection device is known which has a flexible and bendable coupling part disposed between the crystal and the mirror, so that the stiff deflection of the crystal elements can be transferred to the mirror by a kind of hinge effect. This results, however, in a certain attenuation, so that for many applications the speed of the deflections is inadequate. Similarly, the amplitude of the deflection is limited to the amplitude of the crystal.

The whole of the known technique in this field has limitations with regard to the magnitude of the tilting of the mirror, even though attempts are made, as disclosed in USA patent no. 3,981,566, to allow the deflections of the crystal elements to be transferred to the mirror as closely as at all possible to its centre.

The object of the invention is therefore to increase the deflection of the mirror as much as possible, and hereby extend the possibilities of application for such devices.

This is achieved by configuring the instrument according to the invention as disclosed and characterized in claim 1, in that sufficient energy is constantly applied to the mechanical oscillation system for the resonant oscillations to be maintained at

one or more of the system's resonant frequencies. This results in the deflection of the mirror or the mirrors being multiplied many times, depending on the efficiency of the oscillation system. By constructing the mechanical oscillation system in different ways and with the use of different materials, it can be configured so that it assumes one or more resonance frequencies of the desired extent and amplitude, depending on the application for which the instrument is to be used.

By configuring the deflection instrument according to the invention as disclosed and characterized in claim 2, the possibility is provided of generating almost any oscillation pattern for the mirror or the mirrors, and one can hereby make a beam of light which is directed onto the mirror or the mirrors, after reflection from said mirror or mirrors, describe almost any desired path.

The deflection instrument according to the invention can be configured as disclosed and characterized in claim 3, in that this hereby enables the construction of a very compact instrument which is easy to "pump" with oscillation energy, while at the same time control the direction of the mirror's mechanical oscillations.

The deflection instrument according to the invention can also be configured as disclosed and characterized in claim 4. This manner of applying energy to the oscillating system is particularly suitable if several mirrors are to oscillate in step with one another as disclosed and character-

ized in claim 5, but moreover has the advantage that it does not demand operational voltages as great as those necessary for the crystal elements.

By configuring the deflection instrument as disclosed and characterized in claim 6, the reflected light can be made to spread itself over a very much greater area, which is particularly advantageous if the instrument is used for the generation of laser -sweep patterns, e.g. for the reading of line codes for example on goods at a cash terminal, in that with this configuration a high sweep-rate as well as a large deflection can be achieved, and at the same time herewith control over the shape of the pattern.

The invention also relates to a controllable reflecting device as disclosed in the preamble to claim 7, which can be used in deflection instruments as described above. By configuring the reflecting device as disclosed and characterized in claim 7, the possibility is provided of maximizing the deflection and of a relatively simple assembly process for the mirror, which is normally glued directly to a rubber or plastic mounting. The possibility is also provided of achieving more uniform products, and by the selection of the type of plastic or rubber one can change the characteristics of the mirror system with regard to resonant frequencies and quality. By configuring or disposing the plastic or rubber cylinder asymmetrically or as a rectangular cylinder instead of a circular cylinder, one can generate various resonant frequencies in different directions.

The invention also relates to a controllable reflecting device as disclosed in the preamble to claim 8, which can be used in deflection instruments as described above. By configuring the controllable reflecting device as characterized in claim 8, the possibility is provided of achieving a very precise tilting or deflection of the mirror without any significant harmonics. Moreover, the characteristics of the mechanical oscillation system can be varied by the use of balls of different sizes, by the use of different binding materials etc.

By configuring the controllable reflecting device according to the invention as disclosed and characterized in claim 9, the possibility is provided of achieving a very large deflection, in that it becomes possible to dispose the balls closely to each other and close to the centre of the mirror, so that a maximum mirror deflection is achieved for a given deflection of the crystal elements.

By configuring the controllable reflecting device according to the invention as disclosed and characterized in claim 10, the possibility is provided of producing it as a very small and slim construction, for example so that the whole of the reflecting device can be disposed in a tube with an opening for the light.

By configuring the controllable reflecting device according to the invention as disclosed and characterized in claim 11, different resonance frequencies can be generated in different directions in a

simple manner, so that the reflected light can be made to describe a path with a desired form or direction.

The invention has been developed mainly for use in sensing devices such as those in cash terminal installations, stock control installations or other installations which use optically readable line codes, and as disclosed in claim 12. If several synchronously oscillating mirrors are used in the device, one mirror can be used for emitting the laser-sweep pattern, and the others can be used for detecting the reflected light. One hereby achieves quick reading of a line-code label, particularly if it is not positioned in a certain way, which for example is the case with line-code labels on foodstuffs on a conveyor belt at a cash terminal.

The invention will now be described in more detail with reference to the drawing, in that

Fig. 1 shows the principle of the electrically controllable reflecting device according to a first embodiment of the invention,

Fig. 2 shows on a larger scale a section along the line II-II in fig. 1,

Fig. 3 shows a section in fig. 2 on an even larger scale,

Fig. 4 shows the principle of the controllable reflecting device according to a second embodiment of the invention, and shown in

the same manner as fig. 2,

Fig. 5 shows an electrical block diagram which illustrates the control of a deflection instrument with a controllable reflection device according to the invention,

Fig. 6 shows an electrical block diagram which shows the control of a deflection instrument with a controllable reflection device according to a specially preferred embodiment of the invention,

Fig. 7 shows a third embodiment of a controllable reflection device,

Fig. 8 shows a fourth embodiment of a controllable reflection device,

Fig. 9 shows a fifth and particularly advantageous embodiment of a controllable reflection device according to the invention,

Fig. 10 shows the embodiment in fig. 7 seen in perspective,

Fig. 11 shows a sixth embodiment of a controllable reflection device according to the invention,

Fig. 12 shows the same as in fig. 11, but in perspective,

Fig. 13 shows the same as in fig. 11, but seen from below,

Fig. 14 shows the same as in fig. 11, but with an alternative method of securing the plastic or rubber cylinder,

Fig. 15 shows a seventh embodiment of a controllable reflection device according to the invention, and with electromechanical drive system,

Fig. 16 shows an eighth embodiment of the invention, but in which many mirrors oscillate synchronously,

Fig. 17 shows an embodiment of an electromechanical drive system for the embodiment in fig. 16,

Fig. 18 shows an alternative embodiment of an electromechanical drive system for the embodiment shown in fig. 16,

Fig. 19 shows a first example of the pattern of the beam path with the embodiment shown in fig. 6,

Fig. 20 shows a second example of the pattern of the beam path,

Fig. 21 shows a third example of the pattern of the beam path,

Fig. 22 shows, partly in section, a complete defelection instrument according to the invention for the scanning of a line-code label,

Fig. 23 shows an instrument according to an embodiment with a number of controllable reflection devices which are illuminated from the same light source, and

Fig. 24 shows a detail from fig. 23 on a larger scale.

In figs. 1-3 of the drawing it will be seen that a small surface mirror 2 is mounted on four arms 3, said arms being piezoelectric crystal elements, so-called bimorph actuators which, for example, are of the type 4322 020 08250 manufactured by Philips. The size of such actuators is in the order of 1.6 x 0.6 x 12 mm. Together, the mirror 2 and the crystals 3 constitute an electrically controllable reflection device 1. When a potential difference is applied between the upper and the lower sides of the crystals through the leads 3', the crystal will bend. If, as shown in fig. 1, the elements are secured in a stationary part 4, the free ends will be raised or lowered, depending on the polarity and strength of the potential difference.

The crystal elements are arranged together in a staggered cross, in that opposite elements are completely offset from each other, but where all of the elements are arranged so that they form a right-angled cross. Between the free ends there are gaps 9 in the order of 0.1-0.5 mm.

The mirror 2 in the shown embodiment is square, but naturally this can be of any desired shape. Its size is in the order of 3 x 3 mm and it is as thin as is

practically possible, i.e. of a thickness of less than 0.5 mm.

As closely as possible to the centre-facing corner of the elements 3, a bearing element in the form of a ball 5 is secured on each element, said ball having a diameter in the order of or less than 0.5 mm, so that the four balls form a square with as small a side length as practically possible, e.g. 1 x 1 mm or less. The balls 5 are glued to the elements 3, e.g. with epoxy adhesive or the like, and the mirror is coupled to all of the balls 5 by means of a flexible binding agent 7, e.g. silicone rubber or the like. The bearing elements 5 do not need to be balls, in that elements of other shapes can be used, e.g. cylindrical or box-shaped, though preferably with double curvature surface at the coupling to the mirror. The bearing elements can be shaped or fashioned so that the binding agent adheres better hereto, and the mirror can herewith be given greater effects. The bearing elements can be balls of steel or glass, plastic etc., and can be configured with a special surface structure which increases the adhesion. The bearing elements must be large enough to lift the mirror completely free of the elements 3 at maximum deflection, i.e. a diameter of less than 0.5 mm is normally sufficient.

In fig. 4 is seen a second embodiment of the reflection device in which the mirror 2 is secured to the elements 3 by means of a rubber part 8 which, for example, as shown can be a cylindrical tube piece with a central opening 12 which is substantially coincident with the gap 9 between the arms 3. The rub-

ber part is preferably produced of natural rubber or similar material, and is glued to the crystal elements 3 and the underside of the mirror 2.

In fig. 5 will be seen a block diagram of a deflection instrument according to the invention with a controllable reflection device 1. The light from a laser 19 is reflected from the mirror towards a wall or screen (not shown). Oppositely-lying elements in the reflection device 1 are electrically coupled in pairs and in counter-phase, so that those elements which lie in staggered extension of each other move in opposite directions in response to the same applied signal, i.e. the one element bends upwards and the oppositely-lying element bends downwards. The mirror will thus tilt around an axis through the balls or the rubber part, which is shown schematically by the stippled line in the segment figure in fig. 1. In this manner, by applying suitable x-y signals to the two sets of elements, the mirror can be tilted in any desired direction, depending on the phase and the strength of the applied signals. The elements are driven by supplying them with a driving voltage from the drive circuit 20, which is supplied with a DC voltage in the order of +200 VDC. The control signals are applied to the input electrodes 22, and the one x-signal and the one y-signal are inverted by the inversion circuits 30 which, for example, are each built up with their own operational amplifiers as shown.

In fig. 6 is shown a specially preferred embodiment in which the reflection device is driven by two push-pull drive stages 29, one for the x-signals

and one for the y-signals. The two push-pull stages 29 are supplied, for example, with control signals 31 and 32 as shown. In the embodiment shown, both of the signals 31 and 32 are saw-tooth shaped signal voltages modulated with a low-frequency, sinusoidal voltage of, for example, 1/8 of the frequency of the saw-tooth voltages. These voltages are not necessarily synchronized. The saw-tooth voltages have a frequency which lies in the same order as the resonant frequency of the mirror system 1, i.e. the resonant frequency of the mirror system plus rubber part plus possible additional coupling means for the crystal actuators, so that the applied control voltages 31 and 32 will make the mirror 2 tilt at its own resonant frequency, and thus the mirror deflection will be many times greater than the degree of deflection which can be achieved with the embodiment shown in fig. 5.

In figs. 7 and 10 is seen another embodiment of a controllable reflecting device 1 in which the cylindrical rubber part 8 is secured by means of a number of support elements 10, which are secured to the crystal elements 3 with a drop of glue 13. The four crystal elements in fig. 7 can be of different lengths. Several resonant frequencies are herewith obtained in the mechanical oscillation system, and thus great deflection at various frequencies and in different directions can be achieved.

In fig. 8 it will be seen that the flexible rubber part 8 can be configured or arranged in an unsymmetrical manner, so that various resonant frequencies in different directions can be obtained. As

shown, the rubber part can, for example, be in the form of a rectangular cylinder instead of a circular cylinder as shown in fig. 7.

In fig. 9 is shown an embodiment in which the crystal elements 3 are arranged in parallel and opposite one another, thus providing the possibility of making the controllable reflection device very slim and compact, so that, for example, it can be built into a cylinder or the like. The crystals can, for example, be mounted secured between two print plates held together, and the print plates can be double layer plates and configured in such a manner that the pattern on the two layers is identical but merely turned differently.

The support elements 10 in figs. 7-9 are stiff pins, e.g. metal pins, which are glued firmly to the crystal elements 3 with a drop of glue 13. The support elements 10 engage with the rubber part 8, e.g. by being pressed or moulded into the rubber part, or the rubber part can be provided with openings 14 for this purpose. In figs. 7-10 the mirror 2 is shown with stippled lines.

In figs. 11-14 is shown an embodiment of the invention in which the crystal elements 3 are all parallel and disposed around the rubber part 8, on which the mirror 2 is glued. The crystal elements are (not shown) secured against a core with a rectangular or quadratic cross-section. On each crystal element there is mounted (glued) a support element 10 or 11 in the form of a pin 10 or a spring portion 11 which engages with the rubber. With this embodi-

ment, the crystal elements 3 can be allowed to oscillate in phase by pairs. If leaf springs 11 are used, as shown, these can be moulded into the rubber part 8 and glued to the crystal elements. The leaf springs allow oscillations in the two mechanical systems independently of each other and at right angles to each other. As shown, the moulded in leaf springs can be deformed at the moulded-in end in order to improve the adhesion. The coupling together can also be carried out by means of four pins as shown in fig. 14, these being inserted radially into the lower part of the rubber cylinder and secured to the crystal elements via the leaf springs 11.

In all of the embodiments described in the above, the oscillatory energy for the mechanical oscillation system is supplied from electrically-controllable crystal elements. It is also possible to supply the energy in other ways, e.g. by means of an electromechanical system coupled to the rubber part.

Fig. 15 shows a section of an embodiment of the invention in which the mechanical oscillation system is mounted on a guide pin 16 which, for example, is introduced into the opening in a rubber cylinder 8 on which a mirror 2 is glued. In the rubber part 8 there is secured an annular disk 17 which is influenced by a number of electromagnets 15, e.g. by employing permanent magnets 18 on the disk 17. If four magnets 18 and four electromagnets 15 are used, all turned oppositely pairwise, the rubber cylinder 8 with the mirror 2 can be brought into resonant oscillation in any desired direction by controlling

the current to the electromagnets 15.

In fig. 16 is seen the principle of an embodiment of the invention in which a mechanical oscillating system comprises a large number of mirrors 2, each mounted on a rubber part 8 which are all secured (glued) to a common support element 23. If the support element 23 is vibrated in the surface plane, by forced harmonic oscillation the mirrors are made to oscillate in a synchronized manner, so that together the mirrors function as one large mirror which vibrates just as rapidly and with the same amplitude as the small mirror systems. If the support element 23 is influenced by two different resonance frequencies, as indicated by the influencing signals 24, 25, special patterns of movement can be achieved. The individual mirrors are arranged so closely together that the effective reflecting surface is made as large as possible, but far enough away from one another to ensure that there is no contact between them during the vibrations. When such a deflection instrument is used, e.g. in connection with the scanning of line-code labels, one of the mirrors, for example one of the central mirrors, can be used to emit the desired laser-sweep pattern which illuminates the line code, and all or some of the remaining mirrors can be used to scan the reflected light.

Fig. 17 is a sketch showing an example of how the vibrations in the common support element 23 in fig. 16 can be brought into oscillations with an electromagnetic traction coil system disposed closely under the support element 23. For example, the com-

mon support element 23 can be suspended in four spring wires 34, preferably at right angles to the surface. The electromagnetic drive system 33 will thus force the support element 23 to vibrate at right angles to the spring wires 34.

Fig. 18 is a sketch showing an alternative way of suspending the common support element by one centrally-placed spring wire 35, thus enabling the vibration of the support element 23 in its own plane to be overlaid by another vibration having its fulcrum in the securing point of the wire, which as shown can be arranged centrally in the support element. It is thus possible at one and the same time to obtain both rapid vibrations and a slow vibration, independently of each other, and this is achieved by influencing the electromagnetic drive systems 36 partly with a rapid drive signal 39 and partly with a slow drive signal 38.

In figs. 19-21 are shown examples of the light patterns which arise on a plane arranged at a distance in front of the reflected beams of light from a controllable reflection device according to the invention, see for example the plane 37 placed in front of the reflection system 1 in fig. 6. If, for example, this plane is a conveyor 40 at a cash terminal or the like, on which a product with a line code label 41 is passing, it will be seen that the line code is scanned by the laser beam several times.

In fig. 19 is shown the use of a resonant frequency of 2000 Hz with 8 complete sweeps per rotatation,

which occur with a frequency of 250 Hz, so that 250 complete patterns per second are generated.

In fig. 20 is shown an example where a resonant frequency of 2000 Hz is also used, but where use is made of a set of deflection voltages which are not periodic. The area is hereby completely covered with light, in that the pattern is not repeated but constantly displaced, so that the whole area appears illuminated, the reason being that the laser beam is deflected so quickly that one is unable to perceive that only one scanning of the area is involved.

In fig. 21 is shown an example where resonant frequencies are effected in the x-direction with 2000 Hz and deflections in the y-direction with 400 Hz. The picture shown is thus repeated 400 times per second.

In fig. 22 is seen a practical example of how the invention is used in connection with the scanning of line-code label. A screen 46 is secured in a pivotable holder 45 in such a way that the screen can be disposed, for example, over a conveyor on which goods 52 with line-code label 41 are conveyed.

Inside the screen 46 is placed a deflection instrument 47 with a laser, so that, for example, the pattern which is shown in fig. 19 is emitted towards a mirror 49 rotated by a motor 48. From the mirror 49, the laser-beam pattern is thrown out onto a rotating or a number of stationary mirrors 51, so that the goods are illuminated from different sides, thus enabling the line-code label 41 to be scanned, even

though it is not facing directly upwards. For the detection of the reflected light, one or more photocells 50 can be placed at or on the rotating mirror 49. The scanning pattern is hereby brought to cover all directions within the area swept with light.

In figs. 23 and 24 is shown another embodiment of the reflecting device according to the invention, in that a number of reflection devices 1' are arranged in series with one laser 19, and where each reflection device 1' is controlled by each its control and driving circuit 28, which are all controlled by one common control circuit 27, e.g. a programmable computer. The reflection device is seen in greater detail in fig. 24, and in this construction there is used a mirror 2' which is partly reflecting and partly translucent, so that the light from the laser 19 can reach all of the mirrors 2'. For practical reasons, it is necessary with this embodiment for the gap 9' between the elements 3 to be made so broad that the light beam can pass under all conditions. With such a device, a so-called rolling display can be generated, so that a series of characters can be written on a suitable screen placed in front of the device, all controlled by the electronic control circuit 27. With this application, use will be made mainly of reflection devices with balls between the crystal elements and the mirror, and of the kind which has been described in connection with figs. 1-3, in that with this construction a well-defined deflection is achieved without harmonics.

In the application, there is essentially only dis-

cussed transmission of light, i.e. the illumination of a surface with a laser-beam pattern. If this light pattern is used to illuminate line-code labels on goods, the scanning of the information contained in the line-codes is effected in a commonly-known manner, i.e. by an optical scanning of the light reflected from the illuminated line-code label, and the transfer of the optically-scanned signals to electronic circuits of a known kind.

CLAIMS

1. Deflection instrument for light comprising at least one mirror (1, 1') or a reflecting surface supported by and coupled flexibly to a number of movable elements (3, 23), which are controllable or can be manoeuvred under the application of electrical signals or voltages (24, 25, 31, 32, 36, 38), and is arranged in such a manner that the mirror or the mirrors can be tilted away from the position of rest in any desired direction as a function of the electrical signals or voltages, said mirror or mirrors being arranged to reflect incident light, characterized in that the electrical signals or voltages have a frequency or are modulated with a frequency of or in the vicinity of the resonant frequency or harmonics hereof, by a mechanical oscillation system comprising the mirror (1, 1') or the mirrors, the supporting and movable elements (3, 23) and possible coupling means (5, 6, 7, 8, 10, 11) between them.

2. Deflection instrument according to claim 1, characterized in that the movable elements are not all supplied with electrical signals or voltages of the same frequency.

3. Deflection instrument according to claim 1 or 2, characterized in that the movable elements are piezo-electric crystal elements (3), so-called bimorph actuators.

4. Deflection instrument according to claim 1 or 2, characterized in that the movable

elements are electromagnetic elements (15, 18, 33, 36), or elements coupled to electromagnetic elements.

5. Deflection instrument according to claim 1, c h a r a c t e r i z e d in that it comprises a number of mirrors (1) disposed on or connected to a common supporting element (23), said supporting element being supplied with oscillatory energy and forming part of the mechanical oscillation system.

6. Deflection instrument according to claim 1 or 5, c h a r a c t e r i z e d in that in the light path in front of the instrument (47) there is disposed at least one rotating mirror (49) and possibly one or a number of stationary mirrors (51).

7. Controllable reflecting device for deflection instrument for the deflection of light, and where at least one mirror (1, 1') or a reflecting surface is supported by and flexibly coupled to a number of movable elements (3) which are controllable or can be manoeuvred under the application of electrical signals or voltages, so that the mirror or mirrors can be tilted away from their position of rest, c h a r a c t e r i z e d in that the flexible coupling consists of a flexible rubber or plastic part (8) which supports the mirror and is secured or coupled to the movable elements, said rubber or plastic part being configured as a cylindrical tube section with a though-going hole (12).

8. Controllable reflecting device for deflection

instrument for the deflection of light, and where at least one mirror (1, 1') or a reflecting surface is supported by and flexibly coupled to a number of movable elements (3) which are controllable or can be manoeuvred under the application of electrical signals or voltages, so that the mirror or mirrors can be tilted away from their position of rest, c h a r a c t e r i z e d in that the flexible coupling consists of one or a number of balls (5) secured to each of the movable elements (3), and flexibly coupled to the mirror by means of a binding agent (7).

9. Controllable reflecting device according to claim 7 or 8, c h a r a c t e r i z e d in that the movable elements (3) are elongated, substantially rectangular piezo-electric crystal elements with a short side facing towards the mirror and offset for substantially half of their breadth in relation to the central area of the mirror (fig. 1).

10. Controllable reflecting device according to claim 7 or 8, c h a r a c t e r i z e d in that four elongated, substantially rectangular piezo-electric crystal elements are used, these being arranged in pairs in parallel and with coincident longitudinal axes (fig. 9).

11. Controllable reflecting device according to any of the claims 7-10, c h a r a c t e r i z e d in that the piezo-electric crystal elements are not all of the same length (fig. 7).

12. The use of the deflection instrument or control-

lable reflecting device according to any of the foregoing claims, and where the mirror or mirrors are illuminated from at least one preferably monochromatic light source, e.g. a laser, for the illumination of optical line codes (41) in connection with the reading of the information contained herein.

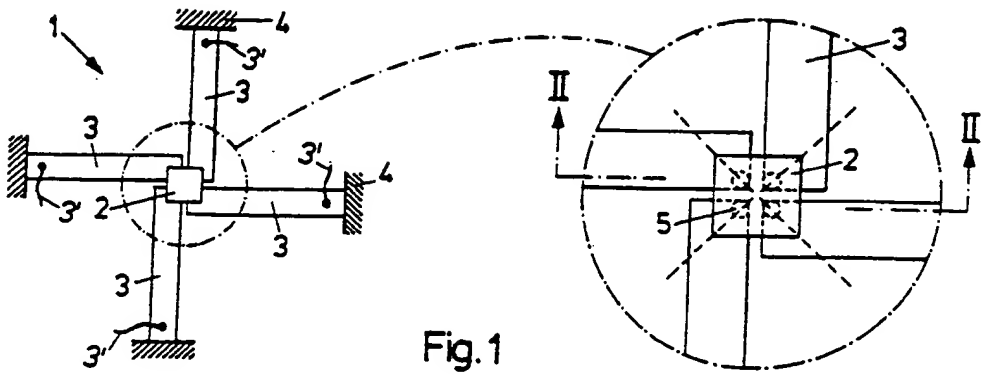

Fig.1

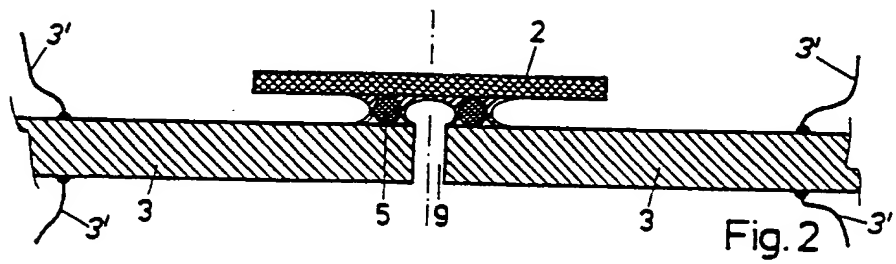

Fig.2

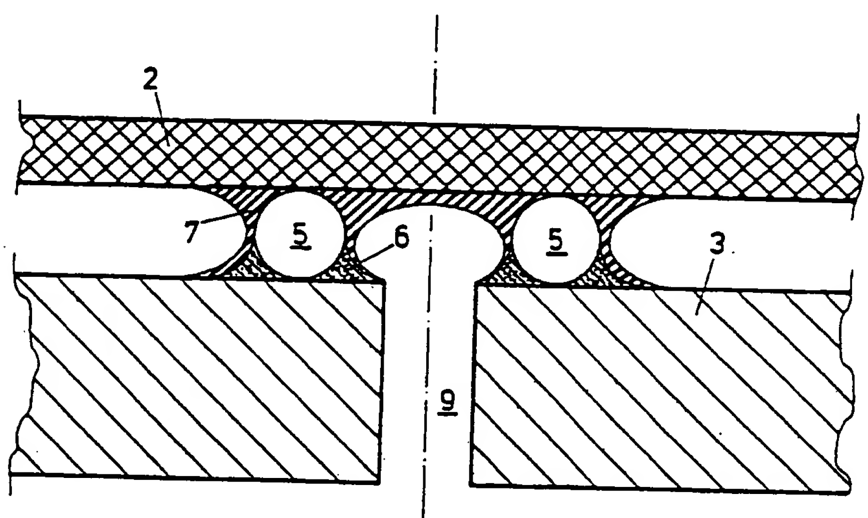

Fig.3

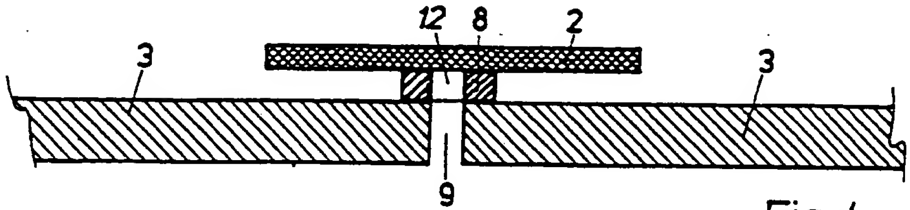
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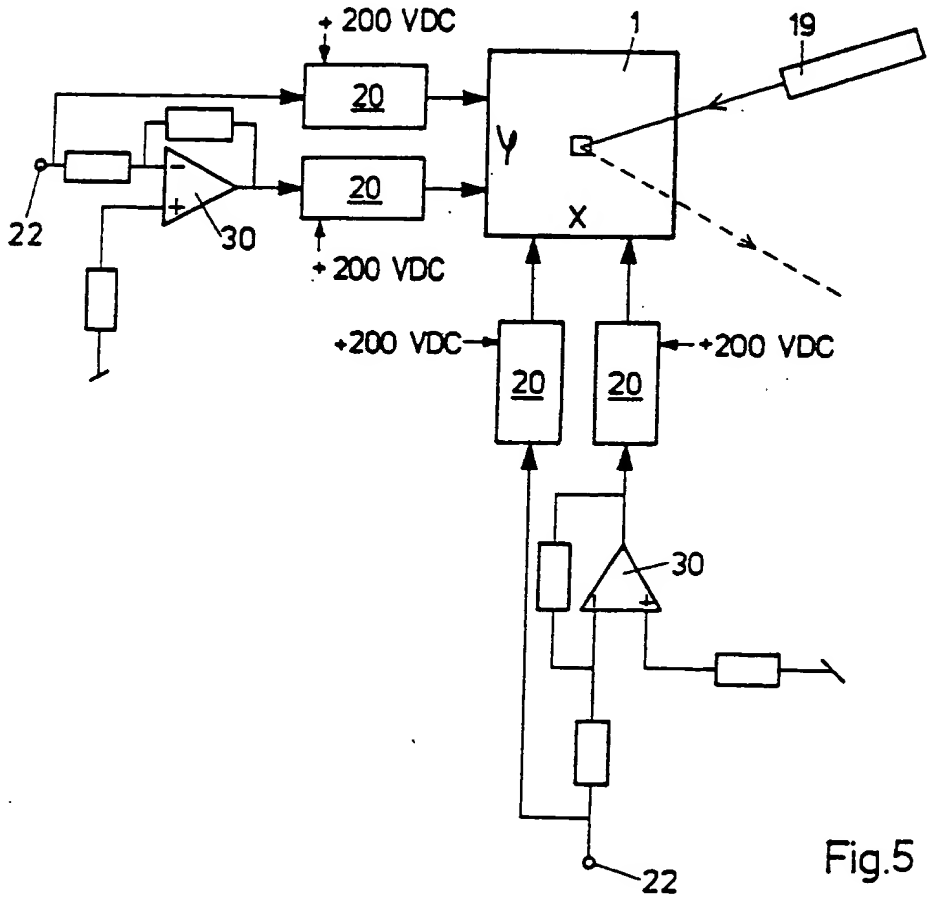
Fig. 4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19
20
20
y
x
22
30
+200 VDC
+200 VDC
20
20
+200 VDC
30
22

Fig.5

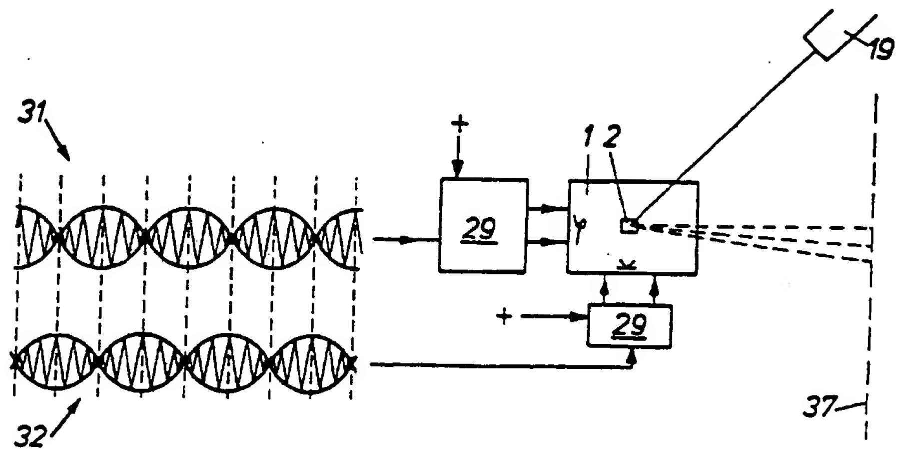

Fig.6

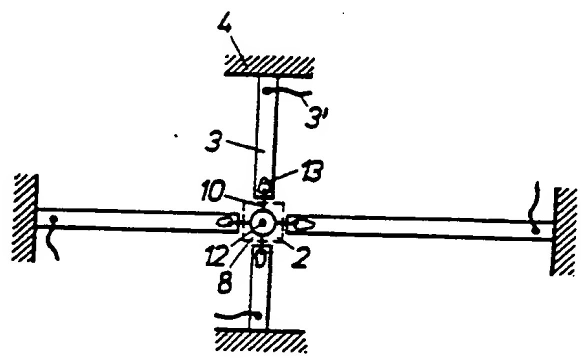

Fig.7

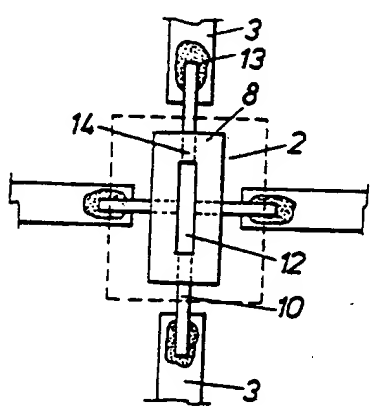

Fig.8

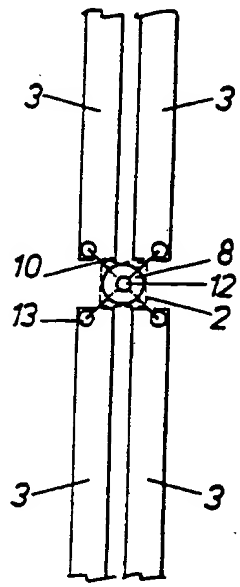

Fig. 9

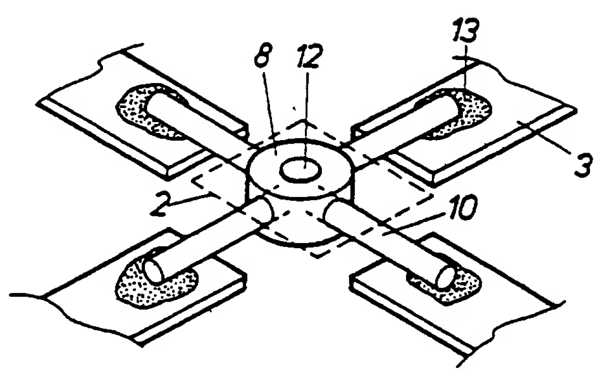

Fig.10

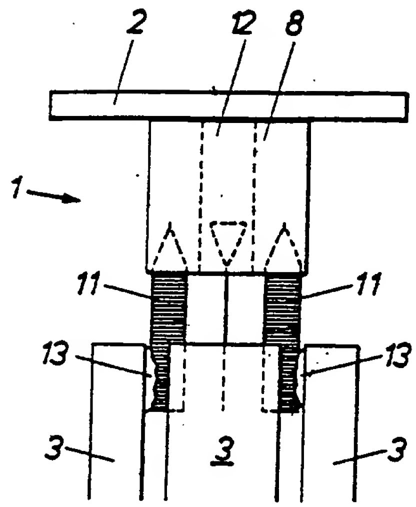

Fig.11

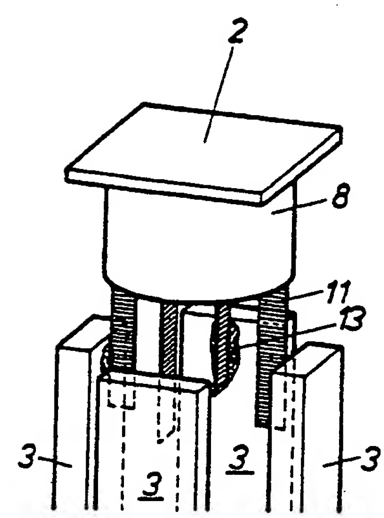

Fig.12

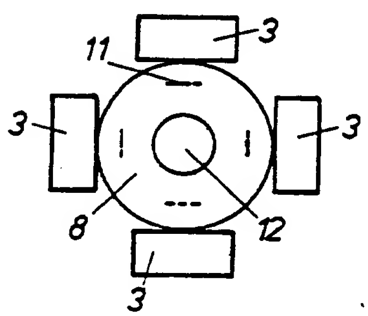

Fig.13

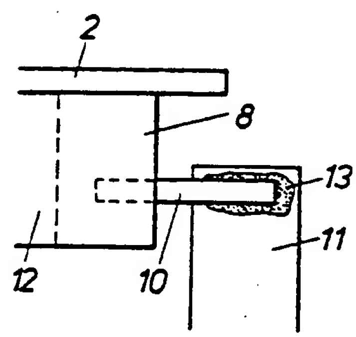

Fig.14

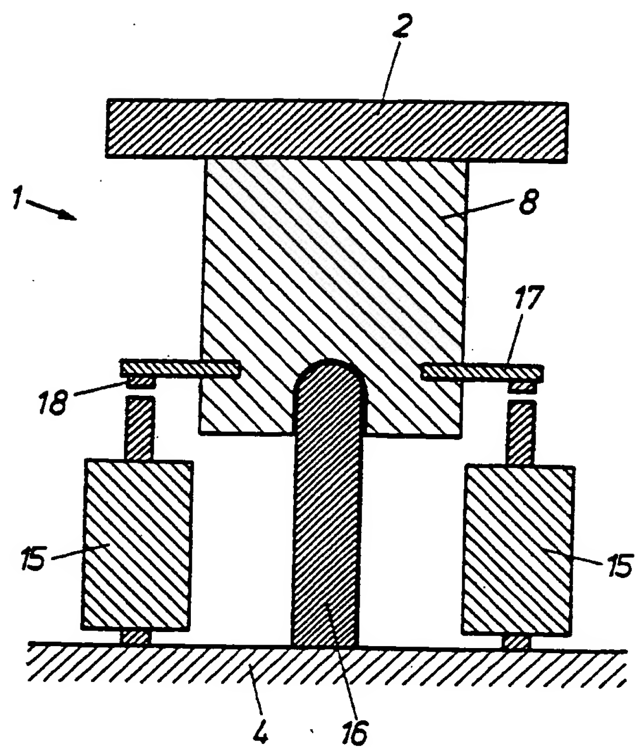

Fig.15

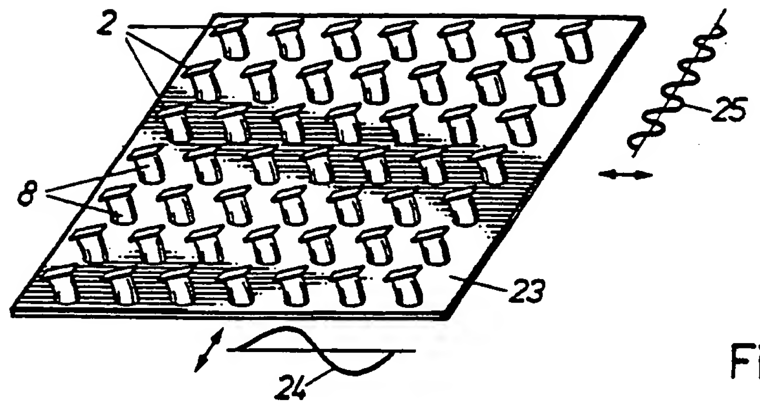

Fig.16

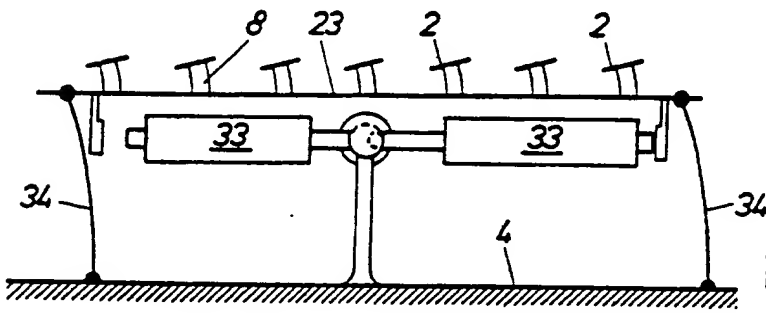

Fig.17

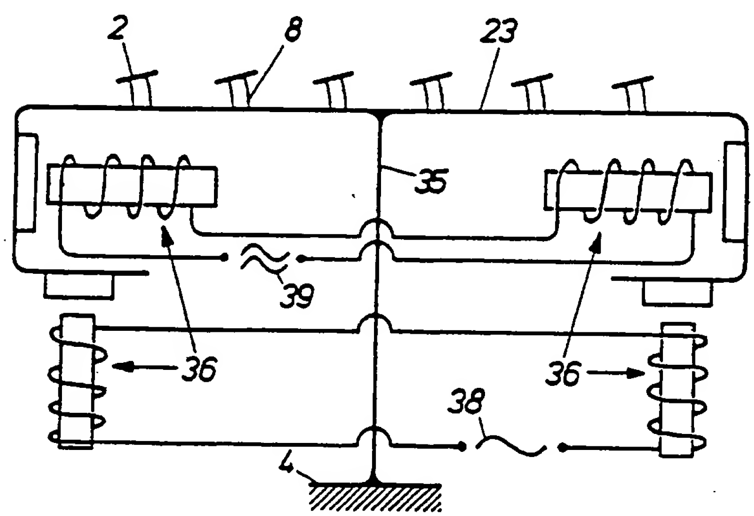

Fig.18

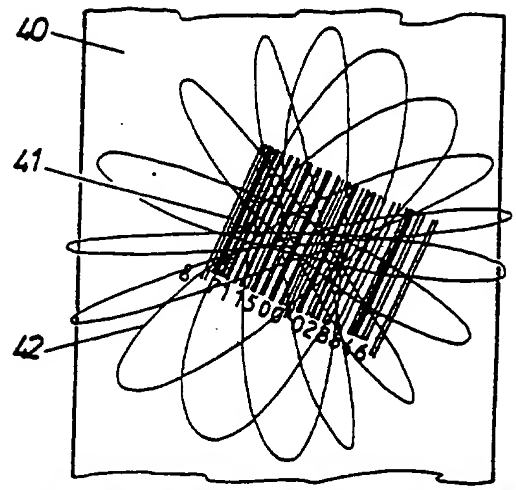

Fig.19

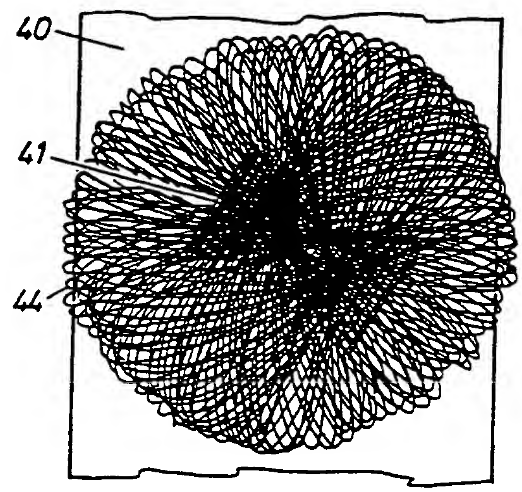

Fig.20

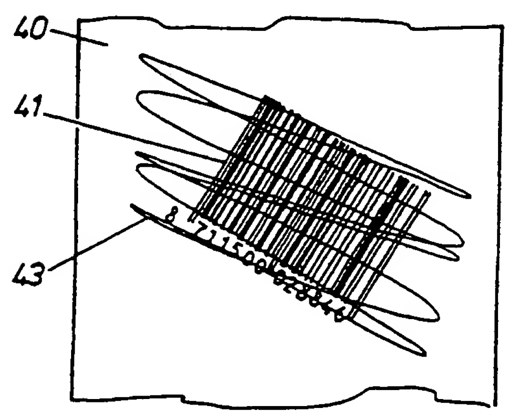

Fig. 21

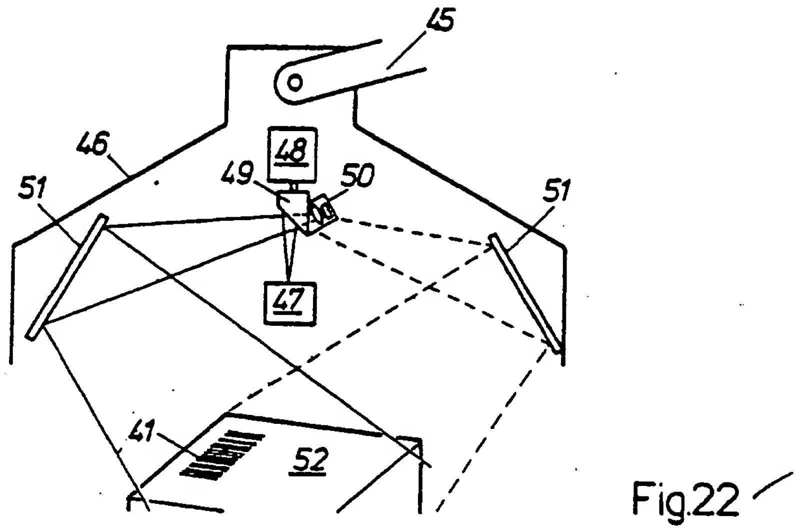

Fig.22

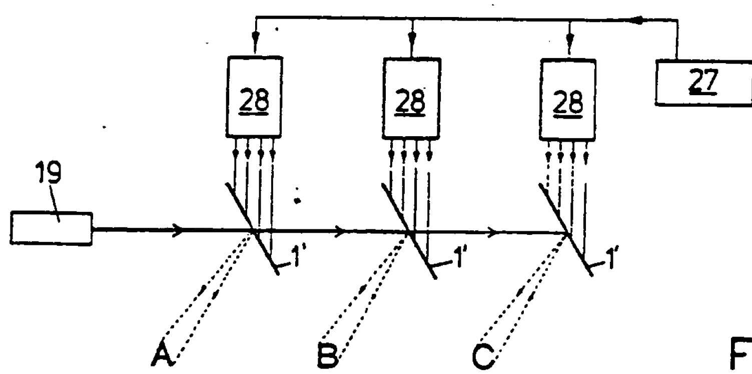

Fig.23

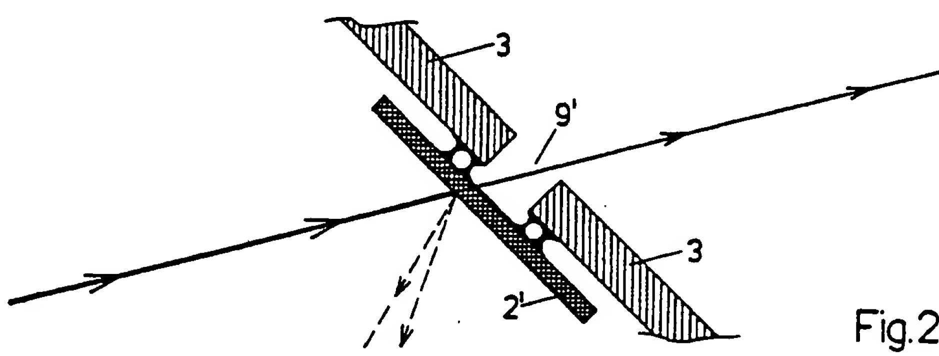

Fig.24

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK89/00190

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

G 02 B 7/18, 26/10, G 06 K 7/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	G 02 B; G 06 K
US Cl	235; 250; 350; 358

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 3 981 566 (FRANK ET AL) 21 September 1976 See column 5, line 57 - column 6, line 8; figure 6	1, 3-4
A	& NL, 7511174 FR, 2285626 DE, 2542233 GB, 1519185 JP, 51060536	7
Y	US, A, 4 708 420 (KEVIN LIDDIARD) 24 November 1987 See column 2, line 67 - column 3, line 8 and claim 6	1, 3-4
A	& WO, 85/05464 EP, 0181891 AU, 571334	7

.../...

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1989-11-15	1989 -11- 23
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Mariana Eddin Mariana Eddin

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3 758 199 (JAMES B. THAXTER) 11 September 1973 See column 3, lines 42-46	1, 3
Y	DE, B1, 2 557 814 (ELTRO GMBH GESELLSCHAFT FÜR STRAHLUNGSTECHNIK) 21 April 1977	4
X	US, A, 3 544 201 (V.J. FOWLER ET AL) 1 December 1970 See column 6, line 69 — line 74 and member 43 in figure 5	7
A	US, A, 4 203 654 (H.B. ELLIS) 20 May 1980 See flexible means 60, 61	
A	US, A, 4 436 364 (REINHARD LAUER ET AL) 13 March 1984 See legs 14 and column 3, lines 1-8	